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ABSTRACT

This paper reports on an investigation into individual differences and group differences in learning styles, test anxiety levels, task performance, and students' attitudes regarding cooperative learning in beginning and advanced biology classes. The Transactional Analysis Inventory (TAI) and Test Anxiety Scale (TAS) were administered to two groups of general biology students and two groups of advanced biology students at a southeast Alabama community college. On the basis of the TAI, students who knew their TAI results were placed into activity groups so that at least two learning styles were represented in each group. At the end of the quarter, students again completed the TAI and the TAS, in addition to the Learning Styles Questionnaire; pre- and post-test scores and beginning versus advanced test scores were compared. Although both students and teachers felt that cooperative learning groups helped to reduce their test anxiety, no significant differences were found between the pre- and post-test TAS scores. Correlations were noted between learning styles and grades with concrete or hands-on learners having the highest grades in both class groups. Findings indicate that group activities not only prevented students from working in isolation, but also helped reduce shyness and increased social skills, team spirit, and a sense of belonging. The learning styles questionnaire is appended. (Contains 19 references.) (NAV)

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COMPARING COMMUNITY COLLEGE STUDENTS' LEARNING STYLES

IN

GENERAL AND ADVANCED BIOLOGY CLASSES

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EDUCATION AND HUMAN RESOURCES:
PUTTING THE PIECES TOGETHER

SP036611

COMPARING COMMUNITY COLLEGE STUDENTS' LEARNING STYLES IN GENERAL AND ADVANCED BIOLOGY CLASSES

An awareness of students' learning styles diversities and test anxiety levels will take the educator one step closer to "Putting the Pieces Together" in the educational realm. An awareness of other students' existing differences in processing materials should increase the students' perception, understanding and tolerance of other's diversities in learning especially when specific teaching techniques suited for these learning styles are presented by the instructor.

Recognition of the students' learning styles may be accomplished through administering a variety of instruments. These include The Learning and Study Strategies Inventory (LASSI) (Weinstein, et.al., 1987) which evaluates ten different areas in the student's study habits and learning styles and the Group Assessment of Logical Thinking (GALT) (Roadrangka, et.al., 1983) which identifies a student's learning style as concrete, transitional, or formal. The Transactional Ability Inventory (TAI) by Gregorc (1978) is a selfscoring instrument in which the individual using a list of defined words rates himself/herself as to which term is most to least like him/her. The results of the TAI categorizes the student into one of four learning styles: concrete sequential, abstract random, abstract sequential, and concrete random. The individual is capable of utilizing all four

types of learning styles depending upon the material to be learned but usually the individual uses only one or two. The teaching techniques for the four learning styles identified by the TAI are different (Gregorc and Butler, 1984.)

The concrete sequential learning style involves hands-on activities and projects to maximize the learning activity. Memorization and drill work are best used by this type learner who learns well with a step-by-step approach. The concrete sequential method of thinking allows one to "label, remember and control discrete parts of the physical environment, ... to work step-by-step, ... [methods] that most vocational or technical fields require" (Gregorc and Butler, 1984, p.28.)

A person who is an abstract random learner relates to the entire environment: room temperature, mood of others, lighting, etc. (Gregorc and Butler, 1984.) This type learner uses emotionality in the learning process and "associates the medium with the message" (Gregorc, 1978.) Since the abstract random learner works well with others cooperative learning group activity and team work would usually be preferred to working alone.

The abstract sequential learner views the overall picture and logically decides a course of events. This type learner enjoys making long-range plans in which the details will be decided later. This type learner prefers to deal with concepts and theories which continually lead to further study (Gregorc and Butler, 1984.)

The concrete random learner is constantly questioning why things are done a certain way. This type learner wants to know

what makes things work and why. Because of this type learner's inquisitive nature, experimenting and inventing are excellent ways for him/her to learn. Diagnosing a problem and approaching a problem in a non-conventional manner are methods by which this type learner succeeds (Gregorc and Butler, 1984.)

The following teaching techniques and work assignments are most useful for the four learning styles of concrete structured, abstract random, abstract structured, and concrete random:

CONCRETE STRUCTURED (CS):

1. Workbooks or lab manuals:
2. Lectures accompanied with overhead transparencies, drawings, or models; demonstration teaching;
3. Hands on materials;
4. Field trips;
5. Programmed instruction.

TEACHER EXPECTATIONS OF CS STUDENTS:

1. Follow step-by-step instructions;
2. Use drill techniques to practice what they have learned;
3. Give correct answers available from the text.

ABSTRACT RANDOM (AR):

1. Movies, [videos], and filmstrips with records;
2. Group discussions among the students;

3. Lecture with discussion of material presented;
4. Television;
5. Short reading assignments which are springboards for class activities.

TEACHER EXPECTATIONS OF AR STUDENTS:

1. Listen to, learn from, and respond to their fellow students;
2. Be aware of color, sounds, and moods in environment;
3. Observe body language, listen for intonation and reflect upon these in connection with the message being given.

ABSTRACT STRUCTURED (AS):

1. Instructional phonograph records;
2. Audio tapes [video tapes];
3. Extensive textbook reading assignments;
4. Slides;
5. Lecture.

TEACHER EXPECTATIONS OF AS STUDENTS:

1. Be willing and able to read large amounts of materials;
2. Be able to conceptualize ideas and convey them either orally or in writing;
3. Be able to concentrate on an idea without being distracted by environmental activities or inner

feelings.

CONCRETE RANDOM (CR):

1. Games or simulations;
2. Independent study projects;
3. Optional reading assignments;
4. Brief mini-lectures;
5. Problem solving activities.

TEACHER EXPECTATIONS OF CR STUDENTS:

1. Frame [form] hypotheses, develop alternative solutions and test them;
2. Be able to solve problems with limited information or data provided;
3. Experiment with ideas and materials through application (Gregorc, 1978.)

RESEARCH QUESTIONS

The investigation was designed to answer questions regarding individual differences and group differences in learning styles, test anxiety levels, task performance, and attitudes regarding cooperative learning. The questions are as follows:

1. Did being in a beginning biology class or an advanced class contribute to each student's performance on the Transactional Analysis Inventory (TAI) (Gregorc, 1978) when the pretest score was compared to the posttest score?
2. Did being in an advanced biology class or beginning

class contribute to each student's performance on the Test Anxiety Scale (TAS) (Sarason, 1972) when the pretest score was compared to the posttest score?

3. Did grouping students into diverse (at least two different learning styles being represented in each group) activity groups (cooperative learning groups) contribute to each student's performance on the TAI when the pretest score was compared to the posttest score?
4. Did grouping students into diverse cooperative learning groups (activity groups) contribute to a reduction in the student's test anxiety score when comparing the pretest TAS score to the posttest TAS score?
5. Did basic biology students when working in diverse cooperative learning groups differ in their task performance from advanced biology students working in diverse cooperative learning groups?
6. Did any correlation exist between the student's learning style as identified by the TAI and the student's task performance in either the general or basic biology class and the advanced biology class?
7. Did students in basic biology classes and advanced biology classes differ in their attitudes regarding cooperative learning using the Learning Styles

Questionnaire (Price, 1991) scores ?

NULL HYPOTHESES

The research questions stated above led to seven null hypotheses:

1. There will be no significant difference between the means of the general biology student's pretest and posttest scores on the TAI and the advanced biology student's pretest and posttest sores as a result of grouping students into diverse (at least two different learning styles being represented) cooperative learning groups.
2. There will be no significant difference between the means of the general biology students pretest and posttest scores on the TAS as compared to the pretest and posttest scores on the TAS of the advanced biology students.
3. There will be no significant difference between the means of the student's pretest and posttest scores on the TAI as a result of grouping students into diverse cooperative learning groups.
4. There will be no significant difference between the means on the student's pretest and posttest scores on the TAS as a result of grouping the students into diverse cooperative learning groups.
5. There will be no significant difference between the

means of general biology students' task performance when compared to advanced biology students' task performance.

6. There will be no correlation between the student's learning style as identified on the TAI and the student's task performance in either the general biology class or the advanced biology class.
7. There will be no significant difference between the general biology students' attitudes using the Learning Styles Questionnaire (Price, 1991) when compared to the advanced biology students' attitudes regarding cooperative learning.

USE OF THE TRANSACTIONAL ANALYSIS INVENTORY TO GROUP COMMUNITY COLLEGE STUDENTS

The Transactional Analysis Inventory (TAI) by Gregorc (1978) was administered to two groups of general biology students and two groups of advanced biology students attending a southeast Alabama community college. For the general biology class, group I had N=21 and group II had N=11 for a total N=33. The advanced biology students' group I had N=24 and group II had N=15 for a total N= 39. The students completed the Test Anxiety Scale (TAS) (16 item version) by Sarason (1978) to measure their test anxiety levels on the same day they completed the TAI. On the basis of the TAI the students were placed into activity groups, small cooperative learning groups, so that at least two of the learning styles were

represented in each group. [Small-group cooperative learning is defined by Parker (1985) as a "classroom learning environment where students work together in small heterogeneous groups on academic tasks" (p.44).] If at all possible all four learning styles were represented in each group similar to the studies by Price (1991, 1992.) According to Wheeler and Flurkey (1990) partners with different styles compliment each others strengths as well as enhance creativity. The author explained the different learning styles according to the TAI of concrete structured, abstract random, abstract structured, and concrete random to each group and emphasized that there was no "good, better, or best" style just different ways that people have of perceiving material and processing that material.

The author informed the students that by knowing their particular learning style they would be able to organize their study sessions and learning activities to enhance their learning. Even though stress management workshops or test-taking skills workshops (Geier, 1986) were not presented to the students, perhaps by working in small diverse cooperative learning groups the students' test anxiety might be reduced. By knowing their learning styles the instructor informed the students that she would be able to organize her class presentations to better suit their academic needs. Academic success as measured by a GPA of 3.00 are above has been linked to students' learning styles in a study by Miller, et. al. (1987.) According to Stewart (1990) in order to determine and meet [instruct] students in appropriate ways based on their

learning styles one must, "first diagnose students' learning styles, ... adapt appropriate teaching-learning components to the students' strengths and preferences; ... evaluate student progress, ... make necessary changes," (p. 372.)

During the quarter especially during the laboratory periods the students worked in their cooperative learning groups for a variety of learning experiences. These experiences included answering questions for the group, studying models, completing experiments, studying microscope slides of fresh and preserved materials, completion on take home or review tests and taking "group" tests to review for the actual examination.

Research has been presented by several authors regarding use of collaborative learning to improve student learning. Basili and Sanford (1991) utilized grouping of community college science students in an effort to improve students' understanding of scientific concepts and to clarify students' scientific misconceptions. Collaborative learning methods with small groups of college students was presented by Hawkes (1991) while Sutton (1992) discussed methods for using cooperative learning groups successfully with high school students stating, "the combination of the use of team building activities, the development of good social skills, and constant guidance from the teacher," (p.65) were necessary. Johnson and Johnson (1993) presented techniques related to how educators can implement cooperative learning including these essentials:

1. Positive interdependence;

2. Face-to-face promotive interaction;
3. Individual accountability;
4. Social skills;
5. Group processing (p.63.)

RESULTS

At the end of the Fall Quarter 1993 the Transactional Analysis Inventory (TAI) by Gregorc (1978) and the Test Anxiety Scale (TAS) by Sarason (1978) were administered to the students as well as the Learning Styles Questionnaire (LSQ) by Price (1991) (Appendix A) regarding students' attitudes about the activity groups. The statistical data regarding the TAI and TAS and the results of the LSQ are in Tables 1-6.

The data from the TAI and TAS was analyzed statistically using the student's t test at the .10 and the .05 significance levels. Information regarding the students' responses to the LSQ was analyzed using percentages. Pretest and posttest scores were analyzed for students in the general biology classes and advanced biology classes. There was a significant difference at the .05 level between the pretest and posttest scores on the Abstract Random learning style of the advanced biology classes ($t=2.454$ with $t=2.042$ being required for significance, Ferguson, 1981,p. 521); therefore, the null hypothesis was rejected for this group. Since there was no significant difference between the means of the other learning styles for either the general or advanced biology classes the null hypothesis was not rejected for these groups.

Pretest scores for the general biology classes were compared to pretest scores for the advanced biology classes and then posttest scores of the general biology classes were compared to the posttest scores of the advanced biology classes for all four learning styles. Both the pretest scores ($t=1.67$ with $t=1.67$ required for significance) and the posttest scores ($t=1.9747$ with $t=1.671$ being required for significance) for the Abstract Random learning style were significant at the .10 level; therefore, the null hypothesis was rejected for these groups. There was no significant difference between the means of either the pretest or posttest scores when comparing the general and advanced biology students' Concrete Structured, Abstract Structured or Concrete Random learning styles; therefore, the null hypothesis was not rejected for these groups.

The total number of each learning style in the general biology classes pretest was compared to the total number of each learning style in the posttest. In the Concrete Structured, Abstract Random and Abstract Structured learning styles there was a significant difference between the means (CS, $t=3.8554$ with significance at $t=2.042$; AB, $t=4.1237$ with significance at $t=2.042$; and AS, $t=10.59998$ with significance at $t=2.042$, Ferguson, 1981, p.521); therefore, the null hypothesis for these groups was rejected. There was no significant difference between the means for the Concrete Random learning style for the general biology classes; therefore, the null hypothesis was not rejected for this group.

The analysis of the Test Anxiety Scale by Sarason (1978)

revealed that there was no significant difference between the means of any of the groups tested; therefore, the null hypothesis was not rejected.

Analysis of learning styles and task performance (student's final grade) revealed a positive correlation between the Concrete Structured (CS) learning style and overall grades of .47, a positive correlation of CS with the number of A's with r=.69, and a positive correlation of CS with the number of B's, r=1.0. There was a positive correlation of the number of B's with all learning styles, r=.55, while the correlation of grades to Abstract Random learning style was a negative one, r=-.578. Since these correlational values were significant, the null hypothesis for each of these groups was rejected. The null hypothesis was accepted for all other groups.

In analyzing the results of the Learning Styles Questionnaire (Price, 1991) responses to several questions showed a strong contrast. Questions 5, 6, 7, 8, 9, 15, 17, and 18 showed the greatest diversity in responses. Question 5 "The lab experiences were beneficial to me when I worked with someone who had a different learning style" had 34.4 % of the general biology responding "strongly agree" while only 7.3% of the advanced biology classes responded similarly. For question 6, "I was able to meet other students in the class much sooner by working in small groups than by not working in small groups," 58% of the general biology class and 44% of the advanced biology class responded "strongly agree;" 19.4% of the general biology class and 34.2% of the

advanced biology class responded "moderately agree;" while 22.6% of the general biology class and 12.2% of the advanced biology class responded, "sightly agree." While none of the general biology class responded to "slightly disagree," "moderately disagree," or "strongly disagree," for question 6 the advanced biology class responded in the following percentages: 2.4%, 2.4% and 4.9%, respectively.

Question 7, "I was able to form a study group or found a study partner with whom I work outside of class as a result of the instructor asking us to work in small groups," presented the greatest differences in the "Strongly disagree" response with the general biology classes, 3.8% and the advanced biology class, 17.5%.

Question 8, "Answering the review lab test questions was more beneficial to me when I worked with another student," had the greatest difference in responses. In the general biology class 46.88% responded, "strongly agree" while only 29.27% of the advanced biology class had this response. Results of the "moderately agree" response was as follows: general biology students-15.63% and advanced biology students-29.27%. The "slightly disagree" response was as follows: general biology students-9.38 and advanced biology students-4.88% and "moderately disagree" had a 3.13 % for general biology students and 9.76% for the advanced biology students. The total percentages for the "agree" responses in both the general and advanced classes were about the same but the degree of agreement was different.

Question 9, "I prefer to study alone in the lab," had the greatest differences in the "Moderately agree" and "Strongly disagree" responses: general biology-6.3%, advanced biology 27.5% and general biology-56.3%, advanced biology-30%, respectively. Overall 84% of the general biology students and 50% of the advanced biology students disagreed with this item.

For question 15, "Working in groups helped to reduce my poptest anxiety," the general biology class agreed by 51.6% and the advanced biology class by 60%; however, the values for "strongly agree," "moderately agree," and "slightly agree" varied noticeably.

Reduction of poptest anxiety due to working with a student with a different learning style was the theme of Question 16. The greatest difference between the general biology and advanced biology students' responses shown in "Slightly agree," with the values of general biology listed as 15.6% and advanced biology listed as 35.9%.

Reduction of lab test anxiety due to working in a diverse cooperative learning group was the theme of Question 18. The three responses, "Moderately agree," "Slightly agree," and "Moderately disagree" had the greatest variation between the general and advanced biology classes as follows: general biology-22.58% and advanced biology-2.56%, general biology-25.8% and advanced biology-43.6%, and general biology-3.23% and advanced biology-12.82, respectively.

DISCUSSION

The Transactional Analysis Inventory (Gregorc, 1978) which presents four learning styles: Concrete Structured, Abstract Random, Abstract Structured and Concrete Random was utilized with general and advanced biology classes. There were no significant differences between the means when comparing pretest and posttest scores for Concrete Structured, Abstract Structured and Concrete Random but there was a significant difference for the Abstract Random learning style group (Table 7.) There was an increase in the number of students with the Abstract Random learning style on the posttest for the general biology class and a significant decrease for the advanced biology class. Perhaps the nature of the advanced biology class required students to approach their studies in a more structured way.

When comparing the general and advanced biology classes as to the total number of each learning style, there was a significant difference between the means for all types except the Concrete Random group.

Even though students responded favorably that working in cooperative learning groups had helped to reduce their test anxieties--poptest, lab test, and lecture test; there was no significant difference between the pretest and posttest scores on the Test Anxiety Scale (Sarason, 1978.) The instructor noted a more relaxed atmosphere in the testing situations involving both the general biology classes and the advanced biology classes, especially when poptest were given--this could have been due to

desensitization on the part of the student because of the large number of poptests given, as well as, having the students work in cooperative learning groups.

In comparing the learning style with task performance, the student's final class average was used. Correlations were found between learning styles and grades. Students with the Concrete Structured learning style (the style which learns best with hands-on experiences) had the highest number of A's and B's in both the general and advanced biology classes. In both the general and advanced biology classes many of the laboratory exercises involved the students working with equipment and models which are hands-on type activities appropriate for the Concrete Structured learner.

Upon analyzing the Learning Styles Questionnaire (Price, 1991) it was noted that the general biology students felt that they had benefited greatly in the laboratory settings by working in diverse learning styles study groups whereas the advanced biology students only moderately agreed that these experiences were beneficial. Part of this difference in response may be due to the nature and organization of the general and advanced biology classes. The general biology class had specific experiments which were done weekly while the advanced class had broader laboratory assignments which were completed over several weeks time.

General biology students agreed that they met others sooner by working in cooperative learning groups. Advanced students may have already known many people in the class because they had been in the same general biology class or had been in other classes together.

The advanced biology classes had a broad spectrum of responses regarding forming study groups which met outside of class. The nature of the advanced class required much outside work and study. Those who preferred studying with others agreed and those who preferred to work alone did not--"Strongly disagreed," general biology-3.75% and advanced biology-17.5%. Perhaps students in the advanced biology classes had established comfortable study patterns including study partners and/or groups and did not want to change these while the general biology students, many of whom were first quarter students, were developing their study patterns and were more flexible.

Approximately 84% of the general biology students agreed that working in groups to answer review lab test questions was beneficial while 83% of the advanced biology students also agreed. Even though both groups agreed the variation in the responses for "Strongly agree," "Moderately agree," and "Slightly agree" were quite different for general and advanced biology students.

Only 3% of the general biology students and 10% of the advanced biology students preferred solitary laboratory study. Most of the students "Strongly disagreed" with this question, especially the general biology students-56.3% (the advanced students-30%.) A total of 84.4% of the general biology students and 50% of the advanced biology students disagreed with Question 9 "I prefer to study alone in the lab." The students' responses supported the usefulness of grouping students into diverse cooperative learning activity groups for both general and

advanced biology classes.

The response to Question 15 indicated that both general and advanced biology students concurred that working in cooperative learning groups helped to reduce their poptest anxiety; however, the advanced class responded to a greater degree. These results may be due to the fact that the advanced biology classes had more poptests than the general biology class.

Students varied in the degree of response to Question 18 regarding reducing lab test anxiety by working in cooperative learning groups. Both general and advanced biology students agreed to some extent that working in cooperative learning groups did help reduce their test anxiety. Perhaps students' anxieties about testing were reduced just because they had someone else with whom they could discuss the material.

The grouping activities not only prevented the students from working in isolation but also helped to reduce many students' shyness and helped to increase their social skills. They also gained a feeling of team spirit and a feeling of belonging to the group and to the class.

The general biology classes were more flexible and more in their attitudes concerning group work than the advanced biology classes. The general biology students appeared to enjoy working in groups more than did the advanced biology student perhaps this was partially due to the differences in the classes- general biology classes have more specific structured experiments in the lab than the advanced biology classes.

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APPENDIX

LEARNING STYLES QUESTIONNAIRE

Key: A=Strongly Agree, B=Moderately Agree, C=Slightly Agree
D=Slightly Disagree, E=Moderately Disagree, F=Strongly Disagree

Circle each answer as it best applies to you and your situation.

---

1. Finding out about my learning style was important to me. A B C D E F

2. The Galt Test helped me identify my learning style. A B C D E F
3. I agree with the results of the Galt Test. A B C D E F

4. Working with other students of different learning styles helped me perceive the material in a different way. A B C D E F

5. The lab experiences were beneficial to me when I worked with someone who had a different learning style. A B C D E F

6. By working in small groups the students worked much sooner groups. A B C D E F

7. With the instructor asking us to work in small groups. A B C D E F

8. Answering the review lab test questions was more beneficial to me when I worked with another student. A B C D E F

9. I prefer to study alone in lab. A B C D E F

10. When studying the models in the lab I learned more when working with another person regardless of their learning styles. A B C D E F

11. I learned more in the lab when working with someone whose learning style was different to mine. A B C D E F

12. Working in groups helped me to learn how to work with people with different learning styles A B C D E F
13. My lab partner and I worked well together because we had different learning styles A B C D E F

14. Working with someone of a different learning style helped to reduce my lecture test anxiety. A B C D E F

15. Working in groups helped reduce my pop-test anxiety. A B C D E F

16. My pop-test anxiety was reduce when I worked with an individual whose learning style differ from mine. A B C D E F

17. Working with someone of a different learning style helped to reduce my lab test anxiety. A B C D E F

18. My lab test anxiety was reduce when I worked with a group of people with different learning styles. A B C D E F

19. Working in groups increased my Anxiety. A B C D E F

20. I prefer to study lecture material by myself. A B C D E F

TABLES

TABLE 1

TRANSACTIONAL ANALYSIS INVENTORY
STATISTICAL DATA
GENERAL BIOLOGY CLASS
N=33

CONCRETE STRUCTURED= CS
CONCRETE RANDOM= CR
ABSTRACT STRUCTURED= AS
ABSTRACT RANDOM= AR

	CS	AR	AS	CR
PRETEST X :	27.64	24.88	23.33	24.18
POSTTEST X :	27.51	25.64	22.91	23.91
STANDARD DEVIATION:	6.58045	5.5158	6.162	6.021625
VARIANCE:	33.66	30.4243	37.9697	36.259968
t=	1.21	1.0796	.00019	.182

(not significant)

TABLE 2
ADVANCED BIOLOGY CLASS
N=39

PRETEST X:	27.41	26.5897	22.0513	21.41
POSTTEST X:	27.589	17.923	21.0256	22.33
STANDARD DEVIATION:	6.765	15.5957	5.99218	4.9764
VARIANCE:	45.76	243.2264	35.9062	24.765
t=	1.6482	2.454*	.75475	.8163

*SIGNIFICANT AT .05 LEVEL.

TABLE 3

A COMPARISON OF LEARNING STYLES
IN
GENERAL BIOLOGY AND ADVANCED BIOLOGY CLASSES

GENERAL BIOLOGY N=33
ADVANCED BIOLOGY N=39

	CS	AR	AS	CR
PRETEST X':	27.64	24.88	23.33	24.18
PRETEST X":	27.41	26.59	22.05	22.41
POSTTEST X':	25.91	25.64	22.91	23.91
POSTTEST X":	27.59	17.923	21.0256	22.333
STANDARD DEVIATION:	6.01049	4.3375	5.01886	4.645
(PRE/POST)	6.5804	16.5246	6.964915	6.2018
VARIANCE:				
(PRE/POST)	36.126	18.8136	25.18897	21.5764
	43.302342	273.06	48.51	38.463
t=	.16174	1.67*	1.069	1.6107
(PRE/POST)	1.0796	1.97466	1.144	1.075

*SIGNIFICANT AT .05 LEVEL.

TABLE 4
NUMBERS OF LEARNING STYLES
GENERAL BIOLOGY
N=33

	CS	AR	AS	CR
PRETEST MEAN:	9	3.5	1	3
POSTTEST MEAN:	7	4.5	2	3
STANDARD DEVIATION:	2.1074	.9847	.3831	.8274
VARIANCE:	4.44	.96968	.14678	.6846
t=	3.8554*	4.1237*	10.59998*	0

* SIGNIFICANT AT THE .05 LEVEL.

TABLE 5
NUMBERS OF LEARNING STYLES
ADVANCED BIOLOGY
N=39

	CS	AR	AS	CR
PRETEST MEAN:	9	6	1	3.5
POSTTEST MEAN:	9.5	7.5	.5	2
STANDARD DEVIATION:	2.168664	1.5198	.2532	.7102
VARIANCE:	4.703	2.30975	.064	.5044
t=	1.018	4.3668*	8.78*	9.34*

* SIGNIFICANT AT THE .05 LEVEL.

TABLE 6
RESPONSES TO THE LEARNING STYLES QUESTIONNAIRE
(STATED IN PERCENTAGES)
GROUP I=GENERAL BIOLOGY, GROUP II=ADVANCED BIOLOGY

		A	B	C	D	E	F
1.	GROUP I:	37.5	18.75	18.75	3.125	18.75	3.125
	GROUP II:	24.39	26.83	36.59	2.44	7.32	2.44
2.	GROUP I:	21.88	43.75	12.5	12.5	0	9.38
	GROUP II:	12.5	22.5	40.00	10.00	10.00	5.0
3.	GROUP I:	20	36.67	33.33	3.33	6.67	0
	GROUP II:	17.95	33.33	35.90	5.13	2.56	5.13
4.	GROUP I:	31.25	31.25	21.88	3.13	3.13	9.38
	GROUP II:	15.00	20.00	35.00	17.5	10.00	2.5
5.	GROUP I:	34.38	25	28.13	3.13	0	9.38
	GROUP II:	7.32	29.27	34.15	14.63	12.20	2.44
6.	GROUP I:	58.03	19.35	22.58	0	0	0
	GROUP II:	43.90	34.15	12.20	2.44	2.44	4.88
7.	GROUP I:	15.63	12.5	9.38	18.75	6.25	3.75
	GROUP II:	20	15	17.5	10	20	17.5
8.	GROUP I:	46.88	15.63	21.88	9.38	3.13	3.13
	GROUP II:	29.27	29.27	24.39	4.88	9.76	2.44
9.	GROUP I:	3.13	6.25	6.25	12.5	15.63	56.3
	GROUP II:	10.00	12.5	27.5	10	10	30
10.	GROUP I:	34.38	15.63	25	6.25	3.13	15.63
	GROUP II:	39.02	24.39	21.95	7.32	2.44	4.88
11.	GROUP I:	28.13	15.63	25	15.63	6.25	9.38
	GROUP II:	2.63	21.05	42.11	21.05	7.89	5.26
12.	GROUP I:	18.75	28.13	28.13	12.5	9.38	3.13
	GROUP II:	10.26	23.08	41.03	12.82	10.26	2.56
13.	GROUP I:	12.9	16.13	25.81	16.13	12.9	16.13
	GROUP II:	5.26	13.16	36.84	15.79	13.16	15.79
14.	GROUP I:	9.38	12.5	25	28.13	12.5	12.5
	GROUP II:	2.44	19.51	26.83	19.51	19.51	12.20
15.	GROUP I:	9.68	29.03	12.90	19.35	12.90	16.13
	GROUP II:	5	15	40	12.5	17.5	10
16.	GROUP I:	9.38	15.63	21.88	18.75	21.88	12.5
	GROUP II:	5.71	11.43	37.14	14.29	22.86	8.57
17.	GROUP I:	15.63	25	15.63	21.88	9.38	12.5
	GROUP II:	7.69	15.38	35.90	15.38	15.38	10.26
18.	GROUP I:	12.9	22.58	25.81	22.58	3.23	12.90
	GROUP II:	10.26	2.56	43.59	17.95	12.82	12.82
19.	GROUP I:	3.13	3.13	25	9.38	12.5	46.88
	GROUP II:	5.26	7.89	18.42	13.16	7.89	42.11
20.	GROUP I:	16.13	19.35	9.68	6.45	12.9	35.48
	GROUP II:	20	17.5	27.5	7.5	7.5	20

TABLE 7
COMPARISON OF LEARNING STYLES
IN
GENERAL AND ADVANCED BIOLOGY CLASSES

CONCRETE STRUCTURED

PRETEST GENERAL BIOLOGY ********************************
(27.64)
PRETEST ADVANCED BIOLOGY ****************************
(27.41)

POSTTEST GENERAL BIOLOGY ***************************
(25.91)
POSTTEST ADVANCED BIOLOGY ********************************
(27.59)

ABSTRACT RANDOM

PRETEST GENERAL BIOLOGY ***************************
(24.88)
PRETEST ADVANCED BIOLOGY ********************************
(26.59)

POSTTEST GENERAL BIOLOGY ****************************
(25.64)
POSTTEST ADVANCED BIOLOGY ******************
(17.23)

ABSTRACT STRUCTURED

PRETEST GENERAL BIOLOGY ************************
(23.33)
PRETEST ADVANCED BIOLOGY ***********************
(22.05)

POSTTEST GENERAL BIOLOGY ***************************
(22.91)
POSTTEST ADVANCED BIOLOGY ***********************
(21.03)

CONCRETE RANDOM

PRETEST GENERAL BIOLOGY ***************************
(24.18)
PRETEST ADVANCED BIOLOGY ***********************
(22.42)

POSTTEST GENERAL BIOLOGY ***************************
(23.91)
POSTTEST ADVANCED BIOLOGY ***********************
(22.33)